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Description

THIS INVENTION relates to capacitors within a motor and, more particularly, to capacitors which have, in the past, been connected to an electric motor.

Such motors may be single-phase induction motors with a capacitor connected to a winding to establish a split phase primarily to establish starting torque. A typical motor of this type has a metal, cylindrical can housing with the capacitor mounted on the outside of the electric motor frame. In a few cases, eg DE-B-2307458 the manufacturer has found room to place the capacitor inside the motor, for example, within the end bell. However, this entails using an elongated end bell and an elongated motor to provide space for such a capacitor.

A half-pitch capacitor induction motor operable on single-phase and having balanced main and auxiliary windings has been disclosed in U.S. Patent 4,371,802. Such a motor has coils surrounding individual pole pieces rather than the usual distributed winding most often found in single-phase induction motors. However, in the motor disclosed by the above mentioned U.S. Patent, the capacitor is mounted externally to the motor.

In the food processing industry, for example, sanitation is essential and a number of electric motors are used. For example for driving fans for refrigeration equipment. In this industry, it is often mandatory to hose down all equipment with a water stream once a week or in some cases, once a day. The electric motors therefore must be capable of withstanding these water splash conditions, and with the externally mounted capacitors of the prior art there was always the problem of properly sealing the interconnections between the metal capacitor housing and the motor housing as electrical leads had to pass between the two. As a result of this, capacitor-type motors were often avoided in the food processing industry and ordinary resistance split-phase/single-phase induction motors were preferred, as the motor housing could be more effectively sealed against water splashed during the cleaning process.

The problem to be solved, therefore, is haw to construct a capacitor-type motor which may be mounted in a motor frame without an external capacitor housing, yet retaining the same size of motor frame so as to be completely interchangeable with a resistance split-phase motor.

It is an object of the present invention to provide a capacitor motor with capacitors inside the motor and between the coils in the motor.

It is a further object of the present invention to provide a single-phase motor with a stator winding having coils on stator teeth and spaces between the coils with capacitors in at least some of the spaces and connected to the stator winding.

Accordingly the present invention provides a capacitor motor comprising, in combination: a magnetically permeable stator; having a plurality of salient teeth establishing a plurality of pole faces thereon; a rotor journalled relative to the stator and magnetically cooperating with the pole faces across an air gap; a stator winding having a plurality of coils on the salient teeth, the coils and teeth having a width in the peripheral direction less than the width of the respective pole face to define a plurality of spaces between at least some of the adjacent coils characterized by at least one elongated capacitor disposed in one of the spaces; and means for connecting said capacitor to said stator winding.

In order that the invention may be readily understood, an embodiment thereof will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a plan view of a motor embodying the invention, with one end bell and the rotor removed;

Figure 2 is a longitudinal section of the complete motor taken on the line 2-2 of Figure 1; and

Figure 3 is a perspective view of an insulator board with mounted capacitors.

Referring now to the drawings, Figures 1 and 2 show an electric motor 11 which has a frame 12 and a magnetically permeable stator 13. This motor 11 may be any one of a number of types, for example, a synchronous motor of the hysteresis or reluctance type, or may be of a type having a permanent magnet for synchronization and utilising induction motor starting. Most of such motors would be single-phase and utilise a capacitor as connected to a part of the stator winding. Such motors may be single-phase induct ion motors which are capacitor-start utilising a start switch to open the capacitor winding at near running speed, or they may be the more popular permanent split capacitor motor without a starting switch. This latter type of motor is illustrated in Figures 1, 2 and 3, as an example of the preferred embodiment.

The motor shown in the Figures is a half-pitch capacitor induction motor, similar to that shown in the prior Patent 4,371,802.

The stator has an even plurality of salient teeth 14 establishing a plurality of pole faces 15 on the stator. These salient teeth extend substantially radially inwardly toward a rotor 16, which is also magnetically permeable. Preferably, both the rotor and stator are made from laminated material to reduce eddy currents produced by the alternating current. The rotor 16 has skewed conductor bars 17 extending longitudinally through apertures in the rotor and joined by unitary end rings 18 to form a squirrel cage rotor cooperating across the air gap 19 with the pole faces 15. The rotor 16 is mounted on a hub 21 which is hermetically mounted to a central shaft 22 and this shaft is journalled in an apertured central extension 23 of the frame 12. The shaft 22 may contain a helical groove 24 to move oil or an other lubricant from a lubricant reservoir 25 secured to one end of the frame 12. This provides lubrication between the shaft 22 and the central extension 23. The shaft 22, hub 21, and laminations of the rotor 16 are all integral and rotate together. The rotor is adapted to drive a load such as the fan blade 26 which is secured to the shaft by a nut 27.

The stator 13 includes a stator winding 30 which comprises a main winding 31 and on auxiliary winding 32. In the preferred embodiment, each winding has an equal number of poles and includes one coil per pole. Figure 1 illustrates one embodiment of the invention in the form of a four-pole motor. Accordingly, the main winding has coils 33, 35, 37, and 39 connected in series by a conductor 41, and the auxiliary winding 32 has coils 34, 36, 38, and 40 connected in series by a conductor 45. The series main winding coils are connected across the input AC voltage source, and the series auxiliary winding coils are connected in series with capacitive means 42 and then across the AC voltage source.

The capacitive means 42 includes one or more capacitors 43 which, in practice, may be three or four individual capacitors 43 mounted on an insulator 44. The insulator is a rigid, arcuate insulator with a radius equal to the radial distance between the shaft axis 28 and the midpoint of the coils 33-40. As each coil spans only a single tooth 14, each coil is made from a conductor which is as short as possible to establish magnetic flux in the respective tooth. Also, one individual coil per tooth establishes spaces 46 between adjacent coils in a peripheral direction, and it is in these spaces 46 in which the one or more capacitors 43 are installed. First and second conductors 47 and 48 are provided on the insulator 44 and these may be provided by printed circuit board techniques or thick film techniques customary in the industry. The insulator board 44 is provided with small apertures through the board which intersect the conductors 47 and 48. Each individual capacitor 43 is provided with an insulating sheath 49 for further insulation between the capacitors and the coils, and each capacitor has first and second leads 51 and 52 which pass through the apertures in the insulator 44 and are electrically connected to the conductors 47 and 48 respectively. This may be achieved by, for example, wave soldering. as at 53, and provides mechanical support for the capacitor from the insulator as well as electrical connection to the conductors 47 and 48. Lead wires 54 and 55 extend from the conductors 47 and 48, respectively, to binding posts 56 and 57. A third binding post 58 is also provided on the stator 13, and these three binding posts may be utilised as terminations for the main and auxiliary windings for connection to two leads 59 and 60, which permit connection to an external AC source.

The subcombination of the insulator 44 and capacitors 43 is shown in Figure 3 as removed from the motor, and Figures 1 and 2 show the capacitors installed inside the motor with the insulator board 44 positioned closely adjacent one end of a plurality of coils 33-40 and the capacitors 43 installed in four of the spaces 46.

In the preferred embodiment, the stator teeth are symmetrically placed around the periphery of the stator, which ensures that the spaces 46 are also symmetrically spaced, although they may be asymmetrical in order to provide additional space at certain preferred locations at which the capacitors could be located. Also in this preferred embodiment, the pole faces are all symmetrical for a balanced half-pitch capacitor induction motor which is energized by single-phase, but actually creates a two-phase motor, with the auxiliary winding 32 establishing a flux electrically displaced substantially 90 degrees from the flux of the main winding 31. This provides a highly efficient motor in the subfractional horsepower size, which is quiet and still has good starting torque.

In one practical motor constructed in accordance with the invention, there are four such capacitors 43 utilised, each being 8 microfarads in capacity, giving a total of 3.2 microfarads when all were connected in parallel by the conductors 47 and 48. These capacitors, when connected in series with the auxiliary winding 32, provide a balanced half-pitch capacitor induction motor with about 15 watts input and 6 watts output, for about 40 percent efficiency. In some cases, only three such capacitors may be utilised, whereas, as many as eight may be utilised in this particular four-pole motor with eight spaces 46. The number of teeth 14 on the stator is twice the number of poles in the motor, and the number of coils equals the number of teeth, so that there is at least one coil on each tooth.

Claims

1. A capacitor motor (11) comprising, in combination: a magnetically permeable stator (13); having a plurality of salient teeth (14) establishing a plurality of pole faces (15) thereon; a rotor (16) journalled relative to the stator and magnetically cooperating with the pole faces across an air gap (19); a stator winding (30) having a plurality of coils (33-40) on the salient teeth, the coils and teeth having a width in the peripheral direction less than the width of the respective pole face to define a plurality of spaces (46) between at least some of the adjacent coils characterized by at least one elongated capacitor (43) is disposed in one of the spaces; and means (47,48,54,55) for connecting said capacitor to said stator winding.

2. A capacitor motor according to claim 1, wherein the stator is journal led in a frame.

3. A capacitor motor according to claim 1 or 2,

wherein the salient teeth are directed substantially radially inwardly from the stator.

4. A capacitor motor according to claim 1,2 or 3, wherein the rotor is disposed inside the stator.

5. A capacitor motor according to any preceding claim, including an insulator which is at least partially circular and has a radius substantially equal to the radial dimension from the axis of the rotor to the spaces, wherein the insulator is disposed at one end of the stator and means for mounting at least one capacitor on the insulator.

6. A capacitor motor according to claim 5, including conductors on the insulator, the mounting means including means for connecting the leads of at least one capacitor to the conductors.

7. A capacitor motor according to claim 6, wherein the conductors are printed on the insulator.

8. A capacitor motor according to claim 5, 6 or 7, including a plurality of capacitors mounted on the insulator spaced in accordance with the position of the spaces between adjacent poles.

9. A capacitor motor according to any one of claims 5 to 8, wherein said insulator is rigid.

10. A capacitor motor according to any one of the preceding claims, wherein each of the teeth has thereon at least one coil of the stator winding.

11. A capacitor motor according to any one of the preceding claims, wherein the coils and teeth are symmetrically spaced around the periphery of the stator.

12. A capacitor motor according to any one of the preceding claims, wherein the pole faces are symmetrically spaced around the periphery of the stator.

13. A capacitor motor according to any one of the preceding claims, wherein the plurality of teeth are two times the number of poles.

14. A capacitor motor according to any one of the preceding claims, wherein the plurality of coils c establish c/2 number of poles.

15. A capacitor motor according to claim 14, wherein the stator winding has a plurality of coils in a main winding and a plurality of coils in a capacitor winding, a pole face being on each of the teeth, and the pitch of the pole face for a pole of the capacitor winding being substantially equal to the pitch of the pole face for a pole of said main winding.

16. A capacitor according to claim 15, which includes a plurality of capacitors, each in a plurality of spaces, and means for connecting the capacitors in parallel and then in series with the capacitor winding.

Patentansprüche

1. Kondensatormotor (11), welcher in Kombination aufweist: einen magnetisch permeablen Stator (13); mit einer Vielzahl hervorspringender Zähne (14), welche darauf eine Vielzahl von Polflächen (15) bilden; einen Rotor (16), welcher relativ zu dem Stator auf einer Welle gelagert ist und über einen Luftspalt (19) magnetisch mit den Polflächen zusammnewirkt; eine Statorwicklung (30) mit einer Vielzahl von Spulen (33-40) auf den vorspringenden Zähnen, wobei die Spulen und Zähne in Umfangsrichtung eine Breite haben, die geringer ist als die Breite der jeweiligen Polflächen, um eine Vielzahl von Zwischenräumen (46) zwischen wenigstens einigen der benachbarten Spulen zu definieren, gekennzeichnet durch wenigstens einen langgestreckten Kondensator (43), der in einem der Zwischenräume angeordnet ist; und Mitteln (47, 48, 54, 55) zum Verbinden des Kondensators mit der Statorwicklung.

2. Kondensatormotor nach Anspruch 1, bei dem der Stator in einem Rahmen auf einer Welle gelagert ist.

3. Kondensatormotor nach Anspruch 1 oder 2, bei dem die vorspringenden Zähne im wesentlichen vom Stator radial nach innen gerichtet sind.

4. Kondensatormotor nach Anspruch 1, 2 oder 3, bei dem der Rotor innerhalb des Stators angeordnet ist.

5. Kondensatormotor nach einem der vorangehenden Ansprüche, der einen Isolator welcher wenigstens teilweise kreisförmig ist und einen Radius hat, der im wesentlichen gleich den radialen Abmessungen von der Achse des Rotors zu den Zwischenräumen ist, wobei der Isolator an einem Ende des Stators angeordnet ist, und Mittel zum Anbringen wenigstens eines Kondensators an dem Isolator umfassen.

6. Kondensatormotor nach Anspruch 5, welcher Leiter auf dem Isolator umfaßt, wobei die Mittel zum Anbringen Mittel zum Verbinden der Drähte wenigstens eines Kondensators mit dem Leiter umfaßt.

7. Kondensatormotor nach Anspruch 6, bei dem die Leiter auf den Isolator aufgedruckt sind.

8. Kondensatormotor nach Anspruch 5, 6, oder 7, welcher eine Vielzahl von Kondensatoren umfaßt, welche auf dem Isolator mit Abstand gemäß der Lage der Zwischenräume zwischen benachbarten Polen angebracht sind.

9. Kondensatormotor nach einem der Ansprüche 5 bis 8, bei dem der Isolator starr ist.

10. Kondensatormotor nach einem der vorangehenden Ansprüche, bei dem auf jedem der Zähne wenigstens eine Spule der Statorwicklung liegt.

11. Kondensatormotor nach einem der vorangehenden Ansprüche, bei dem die Spulen und Zähne um den Umfang des Stators symmetrisch beabstandet sind.

12. Kondensatormotor nach einem der vorangehenden Ansprüche, bei dem die Polflächen um den Umfang des Stators symmetrisch beabstandet sind.

13. Kondensatormotor nach einem der vorangehenden Ansprüche, bei dem die Vielzahl der Zähne das Zweifache der Anzahl der Pole beträgt.

14. Kondensatormotor nach einem der vorange-

henden Ansprüche, bei der die Vielzahl der Spulen c die Anzahl c/2 der Pole festsetzt.

15. Kondensatormotor nach Anspruch 14, bei dem die Statorwicklung eine Vielzahl von Spulen in einer Hauptwicklung und eine Vielzahl von Spulen in einer Kondensatorwicklung aufweist, wobei sich auf jedem der Zähne eine Polfläche befindet und wobei die Teilung der Polfläche für einen Pol der Kondensatorwicklung im wesentlichen gleich der Teilung der Polfläche für einen Pol der Hauptwicklung ist.

16. Kondensatormotor nach Anspruch 15, welcher eine Vielzahl von Kondensatoren, jeder in einer Vielzahl von Zwischenräumen, und Mittel zum Parallelschalten der Kondensatoren und dann zum in Reihe Schalten mit der Kondensatorwicklung umfaßt.

Revendications

1. Un moteur à condensateur (1) comprenant, en combinaison : un stator magnétiquement perméable (13) ayant une pluralité de dents saillantes (14) établissant une pluralité de faces polaires (15) sur celui-ci ; un rotor (16) tourillonné relativement au stator et coopérant magnétiquement avec les faces polaires à travers un interstice (19) ; un enroulement de stator (30) ayant une pluralité de bobines (33-40) sur les dents saillantes, les bobines et dents ayant une largeur selon la direction périphérique inférieure à la largeur de la face polaire respective pour définir une pluralité d'espaces (46) entre au moins certaines des bobines adjacentes, caractérisé par au moins un condensateur allongé (43) disposé dans l'un des espaces ; et des moyens (47, 48, 54, 55) pour connecter ledit condensateur audit enroulement de stator.

2. Un moteur à condensateur selon la revendication 1, dans lequel le stator est tourillonné dans un bâti.

3. Un moteur à condensateur selon la revendication 1 ou 2, dans lequel les dents saillantes sont dirigées sensiblement radialement vers l'intérieur du stator.

4. Un moteur à condensateur selon la revendication 1, 2 ou 3, dans lequel le rotor est disposé à l'intérieur du stator.

5. Un moteur à condensateur selon une quelconque revendication précédente, incluant un isolant qui est au moins partiellement circulaire et a un rayon sensiblement égal à la distance radiale de l'axe du rotor aux espaces, dans lequel l'isolant est disposé à une extrémité du stator, et des moyens pour fixer au moins un condensateur sur l'isolant.

6. Un moteur à condensateur selon la revendication 5, incluant des conducteurs sur l'isolant, les moyens pour fixer incluant des moyens pour connecter les bornes d'au moins un condensateur aux conducteurs.

7. Un moteur à condensateur selon la revendication 6, dans lequel les conducteurs sont imprimés sur l'isolant.

8. Un moteur à condensateur selon la revendication 5, 6 ou 7, incluant une pluralité de condensateurs montés sur l'isolant, espacés selon la disposition des espaces entre des pôles adjacents.

9. Un moteur à condensateur selon l'une quelconque des revendications 5 à 8, dans lequel ledit isolant est rigide.

10. Un moteur à condensateur selon l'une quelconque des revendications précédentes, dans lequel chacune des dents a sur elle au moins une bobine de l'enroulement de stator.

11. Un moteur à condensateur selon l'une quelconque des revendications précédentes, dans lequel les bobines et dents sont symétriquement espacées autour de la périphérie du stator.

12. Un moteur à condensateur selon l'une quelconque des revendications précédentes, dans lequel les faces polaires sont symétriquement espacées autour de la périphérie du stator.

13. Un moteur à condensateur selon l'une quelconque des revendications précédentes, dans lequel la pluralité de dents est égale à deux fois le nombre de pôles.

14. Un moteur à condensateur selon l'une quelconque des revendications précédentes, dans lequel la pluralité de bobines c établit c/2 nombre de pôles.

15. Un moteur à condensateur selon la revendication 14, dans lequel l'enroulement stator a une pluralité de bobines dans un enroulement principal et une pluralité de bobines dans un enroulement de condensateur, une face polaire existant sur chacune des dents, et le pas de la face polaire pour un pôle de l'enroulement de condensateur étant sensiblement égal au pas de la face polaire pour un pôle dudit enroulement principal.

16. Un moteur à condensateur selon la revendication 15, qui inclut une pluralité de condensateurs, chacun dans une pluralité d'espaces, et des moyens pour connecter les condensateurs en parallèle, et ensuite en série avec l'enroulement de condensateur.

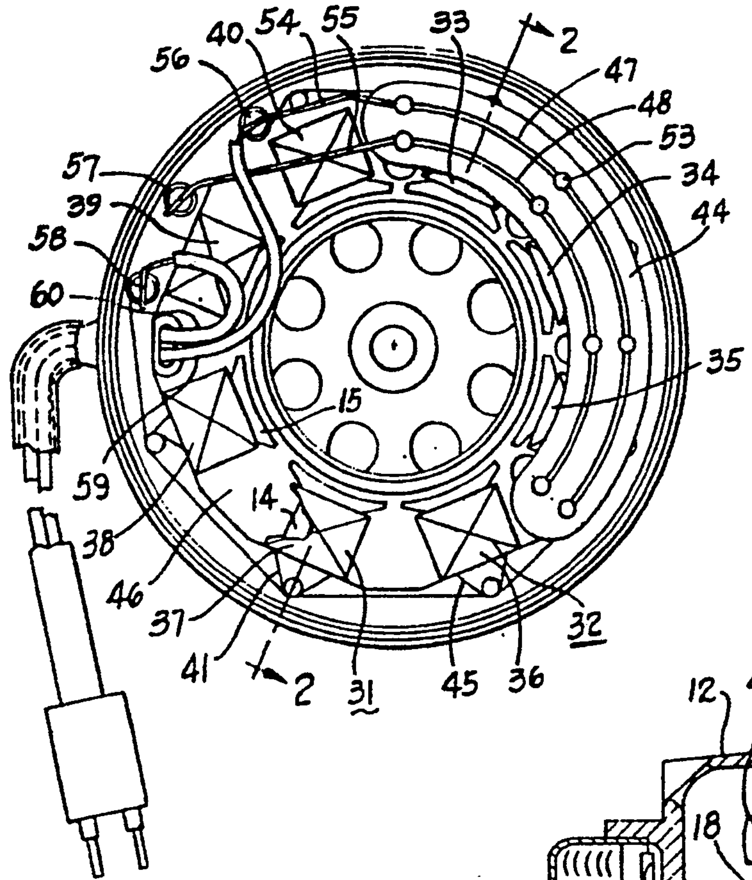

Fig. 1

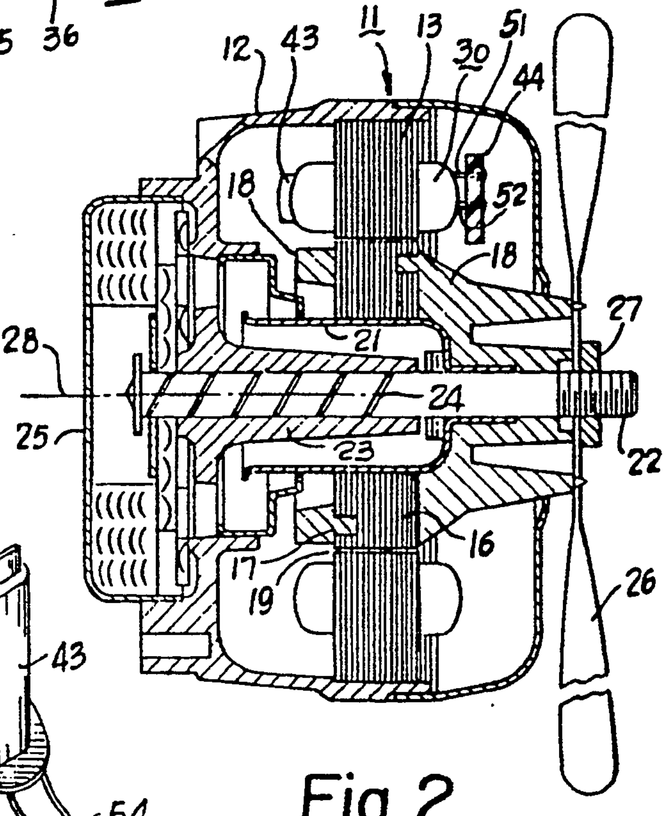

Fig. 2

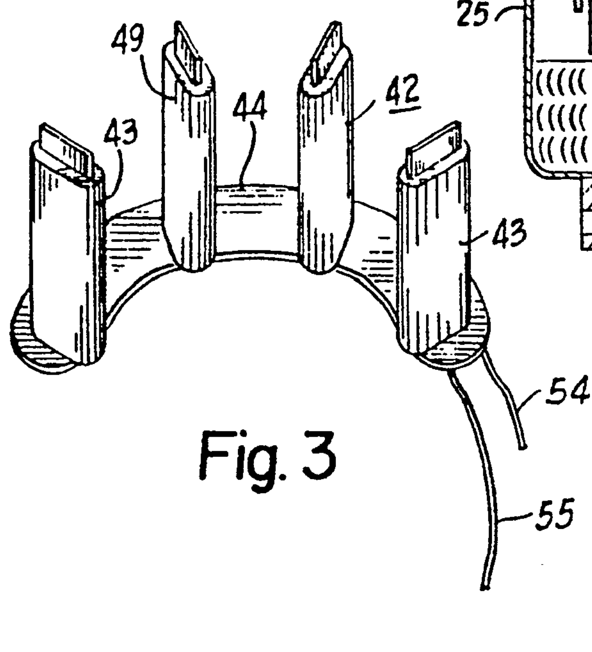

Fig. 3